

WHAT WE CLAIM IS

1. A fluorescent substance comprising a crystal of nitride or oxy-nitride having a β -type Si_3N_4 crystal structure having Eu solid-dissolved into it and emitting a fluorescent light having a peak within a range of 500nm to 600nm in wavelength by being irradiated with an excitation source.

2. A fluorescent substance according to claim 1, wherein said crystal having a β -type Si_3N_4 crystal structure comprises a β -type sialon ($\text{Si}_{6-z}\text{Al}_z\text{O}_z\text{N}_{8-z}$, where $0 \leq z \leq 4.2$).

3. A fluorescent substance according to claim 2, wherein the value of said z is " $0 \leq z \leq 0.5$ ".

4. A fluorescent substance according to one of claims 1 to 3, wherein in case of representing Eu, A (where A is one, two or more kinds of elements selected from C, Si, Ge, Sn, B, Al, Ga and In) and X (where X is one or two kinds of elements selected from O and N) which are contained in said nitride or oxy-nitride crystal with a composition formula $\text{Eu}_a\text{A}_b\text{X}_c$ (where $a + b + c = 1$), a , b and c in this formula meet the following relations (i) to (iii):

$$0.00001 \leq a \leq 0.1 \dots \dots \dots (i)$$

$$0.38 \leq b \leq 0.46 \dots \dots \dots (ii)$$

$$0.54 \leq c \leq 0.62 \dots \dots \dots (iii)$$

5. A fluorescent substance according to one of claims 1 to 4, wherein in case of representing said nitride or oxy-nitride crystal with a composition formula $\text{Eu}_a\text{Si}_{b1}\text{Al}_{b2}\text{O}_{c1}\text{N}_{c2}$

(where $a + b_1 + b_2 + c_1 + c_2 = 1$), a , b_1 , b_2 , c_1 and c_2 in this formula meet the following relations (i) to (v):

$$0.00001 \leq a \leq 0.1 \dots \dots \dots (i)$$

$$0.28 \leq b_1 \leq 0.46 \dots \dots \dots (ii)$$

$$0.001 \leq b_2 \leq 0.3 \dots \dots \dots (iii)$$

$$0.001 \leq c_1 \leq 0.3 \dots \dots \dots (iv)$$

$$0.4 \leq c_2 \leq 0.62 \dots \dots \dots (v)$$

6. A fluorescent substance according to claim 5, wherein in said composition formula $\text{Eu}_a\text{Si}_{b_1}\text{Al}_{b_2}\text{O}_{c_1}\text{N}_{c_2}$, the relation between b_1 and b_2 and the relation between c_1 and c_2 respectively meet the following relations:

$$0.41 \leq b_1 + b_2 \leq 0.44, \text{ and}$$

$$0.56 \leq c_1 + c_2 \leq 0.59$$

7. A fluorescent substance according to one of claims 1 to 6, wherein said excitation source is an ultraviolet light or a visible light of 100nm to 500nm in wavelength.

8. A fluorescent substance according to one of claim 7, wherein said excitation source is a violet light or a blue light of 400nm to 500nm in wavelength.

9. A fluorescent substance according to one of claims 1 to 6, wherein said excitation source is an electron beam or an X ray.

10. A fluorescent substance according to one of claims 1 to 9, wherein said peak is within a range of 500nm to 550nm in wavelength.

11. A fluorescent substance according to one of claims 1 to 10, wherein x and y of the value (x, y) on the CIE

chromaticity coordinates of the color of light emitted at the time of being irradiated with said excitation source meet the following relations (i) and (ii):

$$0 \leq x \leq 0.3 \cdots \cdots \cdots (i)$$

$$0.5 \leq y \leq 0.83 \cdots \cdots \cdots (ii)$$

12. A fluorescent substance according to one of claims 1 to 11, wherein said nitride or oxy-nitride crystal comprises a single crystal of 50nm to 20 μ m in average grain diameter.

13. A fluorescent substance according to one of claims 1 to 12, wherein said nitride or oxy-nitride crystal is a single crystal of 1.5 to 20 in average aspect ratio.

14. A fluorescent substance according to one of claims 1 to 13, wherein the total of impurity elements Fe, Co and Ni contained in said nitride or oxy-nitride crystal is not more than 500ppm.

15. A fluorescent substance according to one of claims 1 to 14, wherein said nitride or oxy-nitride crystal is formed as a mixture containing another crystalline or amorphous compound and the quantity of said nitride or oxy-nitride crystal contained in said mixture is 50wt% (weight percents) or more.

16. A fluorescent substance according to claim 15, wherein said another crystalline or amorphous compound is an electrically conductive inorganic compound.

17. A fluorescent substance according to claim 16, wherein said electrically conductive inorganic compound is oxide,

oxy-nitride, nitride or a mixture thereof containing one, two or more kinds of elements selected from Zn, Ga, In and Sn.

18. A fluorescent substance manufacturing method for manufacturing a fluorescent substance according to one of claims 1 to 17, comprising a process of burning a raw material mixture at a temperature of 1820°C to 2200°C in a nitrogen atmosphere.

19. A fluorescent substance manufacturing method according to claim 18, wherein said raw material mixture contains metal, oxide, carbonate, nitride, fluoride, chloride or oxy-nitride of Eu, and silicon nitride and aluminum nitride.

20. A fluorescent substance manufacturing method according to claim 18 or 19, wherein said nitrogen atmosphere in said process of burning is a nitrogen atmosphere within a pressure range of 0.1MPa to 100MPa.

21. A fluorescent substance manufacturing method according to one of claims 18 to 20, further comprising a process of obtaining said raw material mixture by filling a container with a metal compound in the form of powder or aggregate in a state of keeping said mixture at a filling factor of 40% or less in volume density before said process of burning.

22. A fluorescent substance manufacturing method according to claim 21, wherein said container is made of boron nitride.

23. A fluorescent substance manufacturing method according to claim 21 or 22, wherein said metal compound aggregate is

500 μ m or less in average grain diameter.

24. A fluorescent substance manufacturing method according to claim 23, further comprising a process of making said metal compound aggregate be 500 μ m or less in average grain diameter by means of spray dryer, sieving or wind classification.

25. A fluorescent substance manufacturing method according to one of claims 18 to 24, wherein said burning means is not a means using a hot press but a means using exclusively a normal pressure sintering method or a gas pressure burning method.

26. A fluorescent substance manufacturing method according to one of claims 18 to 25, further comprising a process of grain-size-adjusting the burnt fluorescent substance so as to be powder of 50nm to 20 μ m in average grain diameter by one or plural means selected from grinding, classification and acid treatment.

27. A fluorescent substance manufacturing method according to one of claims 18 to 26, further comprising a process of performing a heat treatment on a fluorescent substance after said burning process or after said grain size adjusting process at a temperature being not lower than 1000°C and being lower than a burning temperature in said process of burning.

28. A fluorescent substance manufacturing method according to one of claims 18 to 27, wherein said raw material mixture contains an inorganic compound forming a liquid

phase at a temperature being not higher than the burning temperature in said process of burning.

29. A fluorescent substance manufacturing method according to claim 28, wherein said inorganic compound forming a liquid phase at a temperature being not higher than said burning temperature comprises a mixture of one, two or more kinds of fluoride, chloride, iodide, bromide and phosphate of one, two or more kinds of elements selected from Li, Na, K, Mg, Ca, Sr and Ba.

30. A fluorescent substance manufacturing method according to claim 29, wherein said inorganic compound forming a liquid phase at a temperature being not higher than said burning temperature is calcium fluoride.

31. A fluorescent substance manufacturing method according to one of claims 28 to 30, wherein said raw material mixture contains an inorganic compound forming a liquid phase at a temperature being not higher than said burning temperature at the ratio of 0.1 to 10 in weight of said inorganic compound to 100 in weight of said raw material mixture.

32. A fluorescent substance manufacturing method according to one of claims 28 to 31, further comprising a process of cleaning said burnt mixture with a solvent so as to reduce the quantity of said inorganic compound forming a liquid phase at a temperature being not higher than said burning temperature after said burning process.

33. An illuminator comprising a light emitting light

source and a fluorescent substance, wherein said fluorescent substance comprises a fluorescent substance according to one of claims 1 to 17.

34. An illuminator according to claim 33, wherein said light emitting light source comprises at least one of a light emitting diode (LED), a laser diode (LD), an inorganic EL device and an organic EL device which emit light of 330 to 500nm in wavelength.

35. An illuminator according to claim 33 or 34, wherein said light emitting light source is a light emitting diode (LED) or a laser diode (LD) which emits light of 330 to 420nm in wavelength, and

said fluorescent substance comprises a blue fluorescent substance having a peak of emitted light within a range of 420nm to 500nm in wavelength, said light being emitted by an exciting light of 330nm to 420nm and a red fluorescent substance having a peak of emitted light within a range of 600nm to 700nm in wavelength, said light being emitted by an exciting light of 330nm to 420nm, and said illuminator emits white light by mixing blue light, green light and red light together.

36. An illuminator according to claim 33 or 34, wherein said light emitting light source is a light emitting diode (LED) or a laser diode (LD) which emits light of 420 to 500nm in wavelength,

said fluorescent substance comprises a red fluorescent substance having a peak of emitted light within a range of

600nm to 700nm in wavelength, said light being emitted by an exciting light of 420 to 500nm, and

said illuminator emits white light by mixing together blue light of said light emitting light source, and green light and red light emitted by said fluorescent substances.

37. An illuminator according to one of claims 33 to 36, wherein said fluorescent substance further comprises a yellow (or orange) fluorescent substance having a peak of emitted light within a range of 550nm to 600nm in wavelength, said light being emitted by an exciting light of 300 to 420nm or 420 to 500nm.

38. An illuminator according to claim 33 or 34, wherein said light emitting light source is an LED or an LD which emits light of 420 to 500nm in wavelength,

said fluorescent substance comprises a yellow (or orange) fluorescent substance having a peak of emitted light within a range of 550nm to 600nm in wavelength, said light being emitted by an exciting light of 420 to 500nm, and

said illuminator emits white light by mixing together blue light of said light emitting light source, and green light and yellow (or orange) light emitted by said fluorescent substances.

39. An illuminator according to claim 37 or 38, wherein said yellow (or orange) fluorescent substance is Ca- α sialon having Eu solid-dissolved into it.

40. An illuminator according to claim 36 or 38, wherein

said red fluorescent substance comprises a fluorescent substance obtained by solid-dissolving Eu into an inorganic material having a CaAlSiN_3 type crystal structure.

41. An illuminator according to claim 40, wherein said inorganic material having a CaAlSiN_3 type crystal structure is CaAlSiN_3 .

42. An image display device comprising an excitation source and a fluorescent substance, wherein said fluorescent substance comprises a fluorescent substance according to one of claims 1 to 17.

43. An image display device according to claim 42, comprising at least one of a fluorescent display tube (VFD), a field emission display (FED), a plasma display panel (PDP) and a cathode ray tube (CRT).